Self-Triggering Method Research Update

EVS-GTR 18th
China
2019.06

Research Progress of Self-Triggering

➢ Background

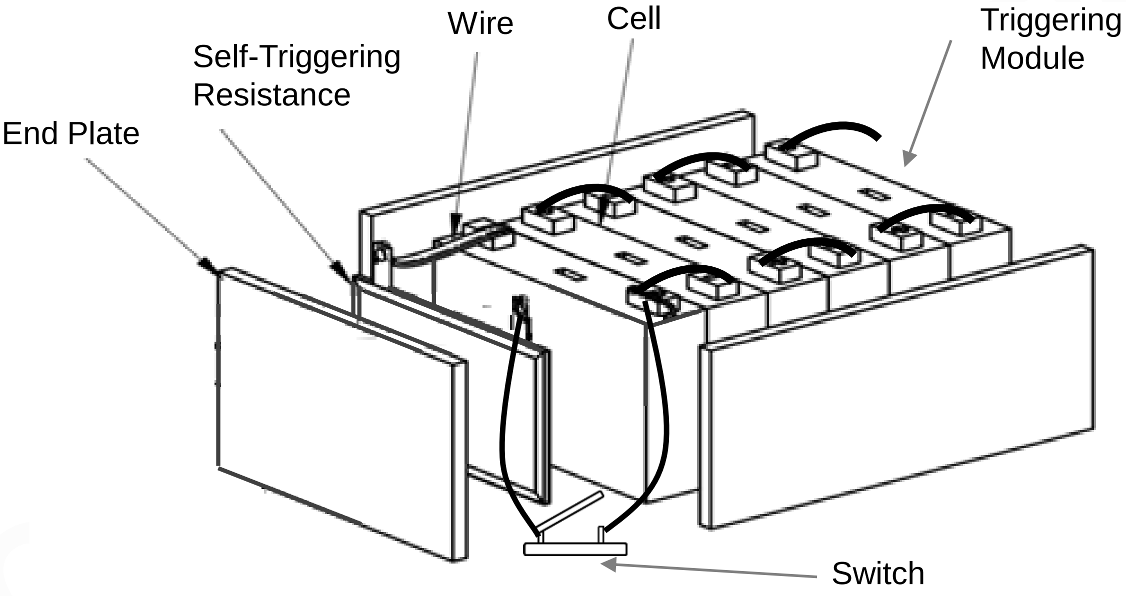
- Name change, “Self-heating” method → “Self-Triggering” method
- The purpose of this method is to use the energy by the battery itself, heating a physical resistance to trigger the battery go to thermal runaway
- The remarkable feature of this method is that there is no additional energy compared to a fully charged cell
- Optimization of test set up and test condition, easy for assembling

Chapter 1

Self-Triggering Method Update

Self-Triggering Method Update

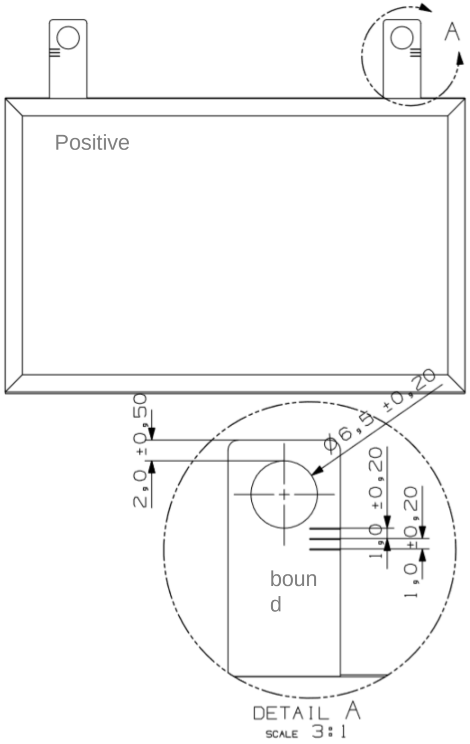
➢ Self-Triggering Module Constructional Sketch



- Remark: trigger cell at the module telos.

Self-Triggering Method Update

➢ The Self-Trigger Device Resistance

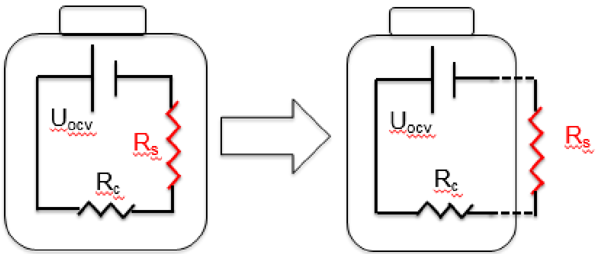


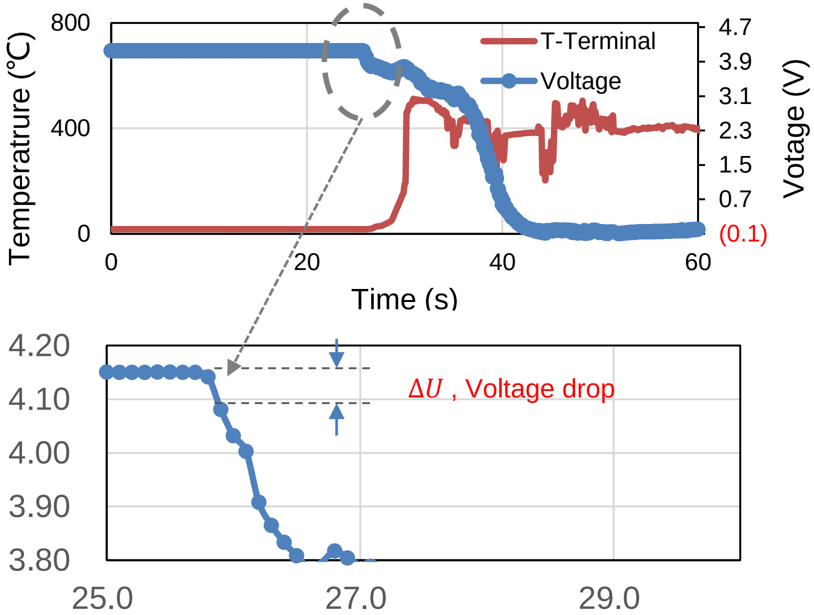
		Ideal Conditions	Reasoning
Material		Metal	Such as Fe_xCo_y alloy, Ag_xCu_y alloy, Ni_xCr_y alloy, et al.
heater	Thickness (mm)	≤5	Thickness contained sealed materials and metal
	Area	not be larger than area of cell surface	Not include the positive and negative terminals
Shape		Planate or others	Covered with ceramics, metals or insulator
Heating Rate (℃/s)		1~10	Depends on the voltage of the triggering cells and the resistance
Minimum heater temperature (℃)		>300℃	↑
Value of Resistance		30~100mΩ	Detail in Blow
Resistance acquisition accuracy		±2mΩ	/
Suitable Cell		/	Pouch & Prismatic

Self-Triggering Method Update

➢ Value of Self-Triggering Resistance

– Calculate internal short resistance(R_s) according to nail test





$$\Delta U = U_{t=0} - U_{t=\varepsilon} = U_{ocv} - U_{t=\varepsilon}$$

$$U_{t=\varepsilon} = (R_c + R_s) * I$$

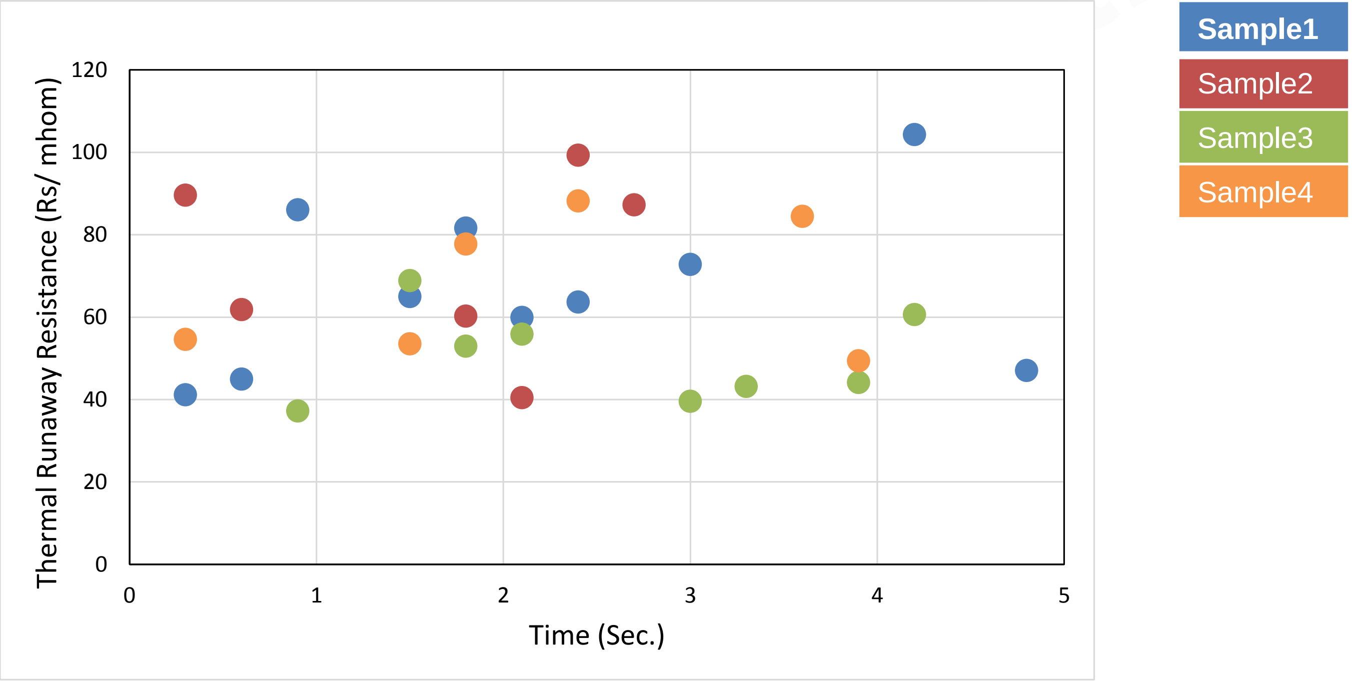
$$\Delta U = U_{t=\varepsilon} - (U_{t=\varepsilon} - R_c * I) = R_c * I$$

Simplified Equation: $R_s = R_c\left(\frac{U_{ocv}}{\Delta U t_{=0}} - 1\right) = 0.5 * \left(\frac{4.15}{0.05} - 1\right) \approx 40\text{mhom}$

Self-Triggering Method Update

➢ Short Resistance Analysis

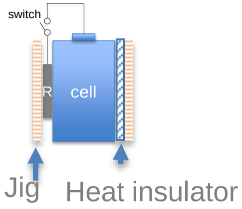
– Herein, we propose internal short resistance(R_s) by nail test to be the self-triggering resistance

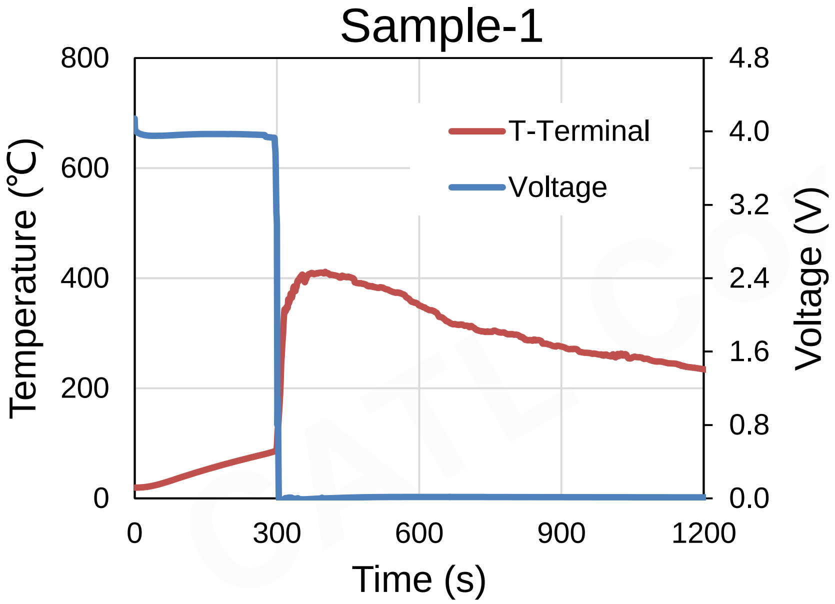


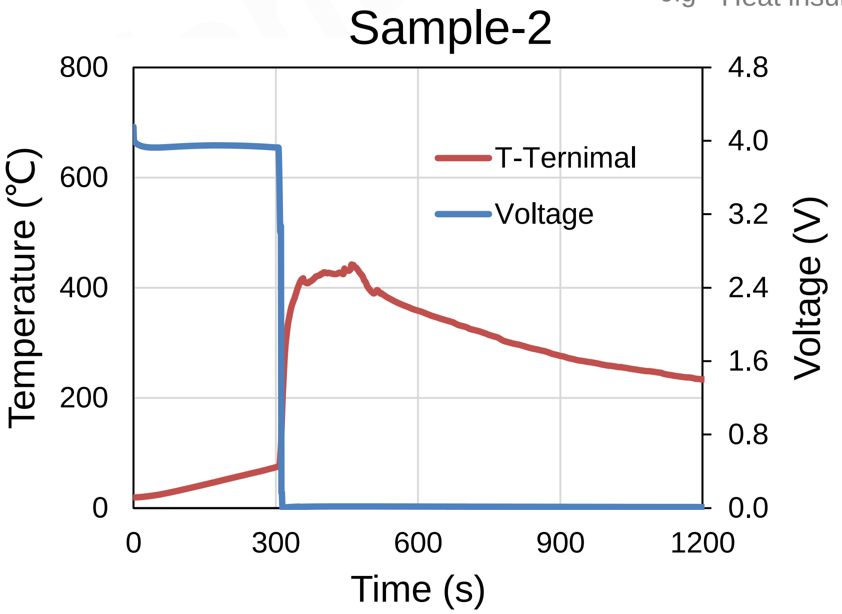
Self-Triggering Method Update

➢ Self-Triggering Resistance Validation

– Use **40mhom** as the typical Self-Triggering Resistance for the Lithium-ion battery.



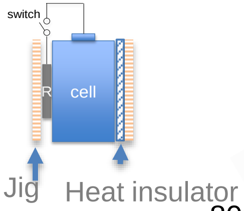


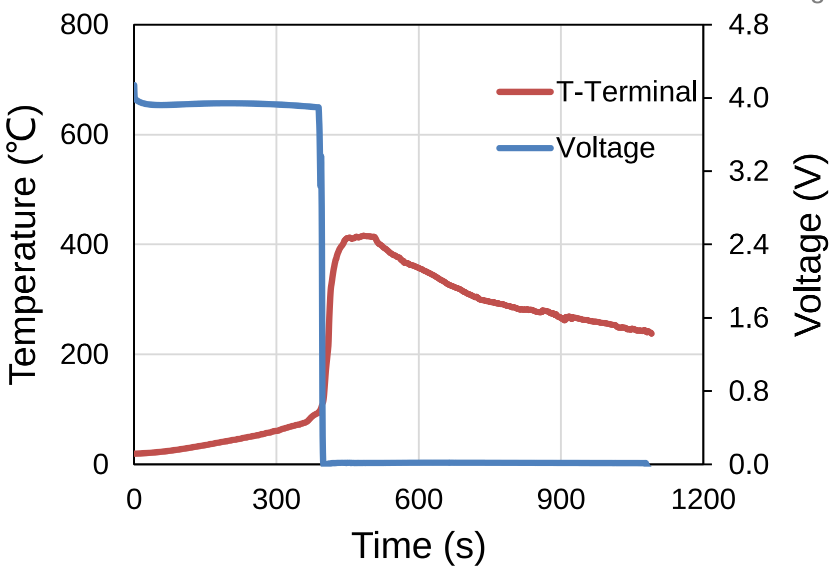


Self-Triggering Method Update

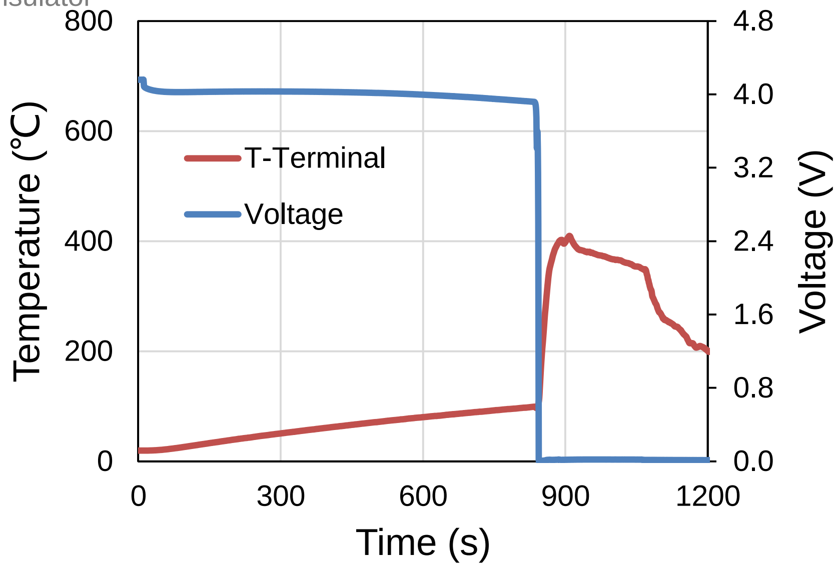
➢ Self-Triggering Resistance Validation

50mhom_Self-Triggering Resistance





80mhom_Self-Triggering Resistance



Chapter 2

Questions & Answers

Questions & Answers

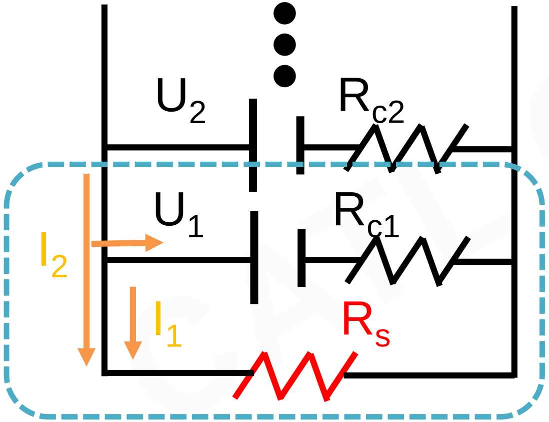
- Question1:
  - Is the Self-Triggering Method like the Discharge case which cause the cell into thermal runaway?
- Answer:
  - Discharge **without energy back** would not cause cell thermal runaway

No.	Test Method	Rate	Initial SOC[a)]	ΔT_Cell Surface	Result
1	Discharge	1C	100%	< 10℃	HL2
2	Self-Triggering	1C	100%	>200℃[b)]	≥HL4

Remark:
a) The operate voltage area is 2.80~4.20V.
b) Temperature before thermal runaway.

Questions & Answers

- Question1:
  - OICA also requested a clarification about the situation of parallel connection of cells (e.g. 4P connection).
- Answer:
  - in parallel cells, the heating energy results from all the parallel ones which is same with the internal short case.



Parallel Cells

No.	Energy (Wh)	Size	ΔT_Cell Surface	Result
1	>400	2P1S	~200℃	≥HL4
2	200~400	3P1S	~210℃	≥HL4
3	<200	3P1S	~204℃	≥HL4

Thanks for Your Attention